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ABSTRACT

The Council for Basic Education cosponsored 11 mathematics and science institutes for secondary school teachers on college and university campuses in 9 American cities in 1984. This approach was a response to the national concern over the state of mathematics and science instruction and was facilitated through support of public and private institutions. This report contains information about the programs' formats and offers suggestions for future planners and participants of similar projects. Program descriptions include: (1) planning phases; (2) recruitment, selection and orientation procedures; (3) curriculum and instruction emphasis; (4) incentives and stipends offered; and (5) evaluation and follow-up plans. Evaluative comments of the summmer experience are given by the participants. An appendix contains a listing of the school districts, universities and funders that were involved in the institutes. Two of the "lessons" learned from the institutes are that early clarification of the aims and emphases of an institute is all-important and that careful thought could be given to requiring an orientation session at which all aspects of the institute are canvassed. (ML)

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# *The Anatomy of Teacher Institutes: A Design for Professional Development*

*A Report*
*on*
*Mathematics and Science Institutes for Secondary School Teachers*
*by*
*The Council for Basic Education*

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# *The Anatomy of Teacher Institutes: A Design for Professional Development*

***A Report***
***on***
***Mathematics and Science Institutes for Secondary School Teachers***
***by***
***The Council for Basic Education***

*A report prepared for the Council for Basic Education, from its files and from interviews, with the assistance of James M. Banner, Jr., senior research associate of the Council.*

The Council for Basic Education acknowledges with appreciation the counsel and assistance of the following persons who served on its Mathematics and Science Advisory Committee.

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The Council for Basic Education is a nonprofit organization established in 1956 by a group of educators and citizens who believed that an education in the liberal arts should be available to all children. The Council assists parents, teachers, administrators, policymakers, and others who are working to invigorate teaching and learning in the basic academic disciplines.

Council policy is determined by a Board of Directors made up of educators and business and civic leaders. Policy and programs are carried out by the staff, under the direction of Executive Director A. Graham Down.

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# *Preface*

Ask today's science or math teachers who were teaching in the 1960s what they remember most fondly about professional life in those days and the answer is invariable: institutes. By that they refer, usually, to the summer institutes funded by the National Science Foundation. How can this popularity be explained? Consider:

- Teachers like to understand the subjects they teach, *want* to understand. It makes the job of teaching more fun, less threatening. Yet until the institutes came along, practicing teachers had precious few ways to dig into their disciplines deeply enough to gain a sense of being reasonably up-to-date.
- Teachers of a given subject like, as do other professionals, to have the chance to exchange ideas, share problems, learn new techniques, and talk shop—especially in the context of mutual learning. But teachers were then, as now, essentially isolated from each other professionally all year long, and so they came quickly to see the summer institutes as the best opportunity available.
- There has always been a lot of talk about the value, to both sides, of collaboration between high school and college teachers in the same field. Talk, but not much action. Not, that is, until the advent of the NSF institutes.

In short, for many teachers of science and mathematics, "institute" meant opportunity for growth, for professional companionship, for widened horizons. The institutes added zest to the agenda. It is no wonder, then, that teachers felt the loss of the institutes in the 1970s and '80s so acutely—and recall those "golden years" with such pleasure.

But now, like the reappearance of Humphrey Bogart films (in, alas, those multimincontainers that today pass for movie theaters), the summer institutes are making a comeback. Fortunately, we seem to be rediscovering what we knew all along but had put out of mind: our country needs citizens who are well educated in science and mathematics, and that takes good teaching, and that in turn means teachers who know their subject and their business. So we are now reinventing institutes. Good, and none too soon.

In doing this, we cannot, however, simply pick up where we left off. For one thing, fond memories notwithstanding, not all of the earlier institutes were good enough to merit resuscitation. For another, we are dealing with an *idea*, not a thing that can be taken out and replayed as it was, like a Bogart film. A summer institute for teachers of science and math is an organic creation, carefully shaped to fit the particular circumstances of its time and place. If the institutes of today are to be effective, they must be designed to meet the specific professional needs of the teachers now in the schools in a particular location, must do so in the context of a clear national mandate to improve the science and mathematics education of all children, not just that of the future scientists and engineers, and must forge stronger and longer-lasting relationships than last time around between schools and colleges.

In all of this, the part being played by the Council for Basic Education can, I believe, be significant. Already it has succeeded as instigator, marriage broker, go-between, and sometime fund-raiser. I, for one, hope that the incredible commitment and resourcefulness of Graham Down and his colleagues hold out for many more seasons, and that what they have put together will survive, serving teachers, serving our nation.

Now, with this slim volume, the CBE contribution is being extended. There are no pat answers to be found here, no formulae for certain success. What there is, is a thoughtful sharing of closely examined experience. Science and mathematics institutes are urgently needed for the nation's high school teachers—but given the severely constrained resources available for this, each one must be of the highest caliber. Perhaps this report will help those who design and conduct institutes achieve this ambitious goal.

*F. James Rutherford*
*Chief Education Officer,*
*American Association for the Advancement of Science*

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# *Introduction*

During the summer of 1984, the Council for Basic Education cosponsored 11 mathematics and science institutes for secondary school teachers on college and university campuses in nine American cities. The institutes served roughly 325 teachers from a wide range of junior and senior high schools. The text that follows is a report of these institutes.

Summer institutes for American teachers are not novel. They have been held frequently before. What distinguished those sponsored by the Council in 1984 was their focus on subject content; their respect for teachers as serious professionals who aspire to increase their learning and teaching skills; their support from local school districts, foundations, and individuals; and their marriage of people of shared commitment from the kindred worlds of secondary and higher education.

A report of these institutes—of both their achievements and the obstacles that they met—would be instructive at any time, sometimes cautionary, occasionally inspiring. We believe, however, that a report of the many dimensions of these institutes is especially timely now in view both of prospective future funding by the federal government of analogous mathematics and science institutes and of similar endeavors in the fields of the humanities with the support of other agencies and foundations.

Therefore, we have sought to capture information about the institutes directly from participants—the teachers who attended them, the college and university faculty members who taught them, school principals and superintendents, teaching assistants, foundation and corporate officers, and members of the Council's own advisory committee—while their recollections are fresh, their observations keen, and their enthusiasm high.

Yet our intent is not simply to provide a record of events. We hope, instead, that a report of this kind can offer guidance to those who plan and participate in similar projects in the future.

The tale of the circumstances and events of the 1984 institutes, we are confident, should assist others in designing and managing not only federally sponsored mathematics and science institutes, but efforts toward serious summer and academic year inservice education in all subjects—history, literature, foreign languages, and the arts, as well as mathematics and the sciences—under all auspices, both public and private. What is at stake is nothing less than the skills and knowledge of our teachers and students.

## A Word About the Council for Basic Education

As the need for the education and reeducation of American school teachers in mathematics and sciences became a critical national issue in the early 1980s, the Council for Basic Education, a nonprofit membership association located in Washington, D.C., came to assume a special role. Neither a grant-giving organization nor an educational institution, it chose, in addition to its other programs, to create local partnerships between private funding sources, public agencies, and local colleges and universities in some of the cities in which its work was already known and where the desire to advance the learning and skills of local school teachers was already manifest and strong.

It was a new kind of venture for the Council, an experiment, one that it undertook with confidence but without experience. It was seeking to take advantage of the national concern over the state of mathematics and science instruction and of the growing interest in arrangements between public and private institutions. Outside observors, partici-

pants in the institutes, and its own advisory committee have concluded subsequently that its work was a success. It helped create public-private alliances. It promoted fresh and stronger links between local schools and neighboring colleges and universities. Above all, it contributed to the retraining and the reinvigoration of teachers throughout the country.

Equally important was the Council's function as a neutral general administrator of the institutes. The Council relieved participating institutions of many responsibilites normally associated with efforts of this sort. It helped raise funds. It received, distributed, accounted for, and reported on the use of all grant monies. Its representatives monitored and evaluated the activites of the institutes. And in the fall of 1984, it convened a meeting of representatives of the institutes and their financial backers to review the institutes' strengths and weaknesses and to lay plans for future endeavors.

The Council plans to maintain its mediating and brokerage role in the future. It does not believe, however, that its own involvement or that of similar brokering organizations is critical to the long-term administration or success of summer or other institutes in any subject. The achievements and strength of any institute depend chiefly upon the skills of its local sponsors and the dedication of its teacher-participants. It is out of this conviction, rather than from any sense of the indispensability of its own role, that the Council for Basic Education publishes this report. We hope that it will convince others to embark on the same kind of venture and that it will help them as they do so.

## CHAPTER 1

# *Planning*

First decisions: they govern everything that follows. Some are made by indirection, others are embraced purposefully. Rarely are conditions for arriving at them ideal. In preparing for the 1984 summer institutes, time was often very short, previous experience limited, participants strangers to each other, and conditions new and uncertain. Yet in every case, the same issues had to be faced, plans for the same challenges fashioned.

### The Planning Group

Antecedent to every planning effort—and an integral part of it—were decisions about the composition of the planning group itself.

Since the 1984 summer institutes originated as cooperative efforts between local school systems, local colleges and universities, and local funding sources, representatives of each of these groups, often brought together by the Council for Basic Education, met from the outset to plan each institute. The most critical participants were those from the schools and those from the institutions of higher education. In some cases, both superintendents and senior officers of colleges and universities, occasionally the president, attended the initial and early meetings of a planning group. Eventually, those who would be most directly responsible for instruction and for the administration of the institutes remained as the functioning planning groups, and in every instance participants were satisfied with that evolution. In at least one case, the initiative for the institute having come from a local university, school officials long remained suspicious of the faculty until they were convinced that the institute was genuinely to be a joint effort.

Occasionally, staff members of the local foundations and corporations that helped support the institutes attended the early planning meetings. Yet as is well known, many funding agencies are notoriously unconcerned to involve themselves in projects that they support or to play any role in visiting or evaluating them, even when nearby and accessible. Despite the Council's repeated invitations to corporate and foundation officers that they attend sessions of their institutes, take applause, gain publicity, and learn first-hand of the instructors' and teachers' work, none—with one exception—did so. And that exception was instructive, in that it combined continuing interest in the program with studied noninterference in professional decisions.

A large national corporation known for its support, both directly and through its foundation, for education, the arts, and the humanities, was a major funding source for three institutes in a city in which it conducted a major portion of its business and remained a presence at those institutes throughout their sessions.

It held a reception for all institute participants, and its public affairs office actively sought local publicity for the institutes. Yet its officers in no way intervened in decisions about such issues as the curriculum or the recruitment of teachers to the institute. When asked whether the corporation had shown unusual self-denial, a senior member of its staff answered in the negative. "The company," he said, "sought only the improvement of math and science in the city's schools and whatever publicity and good will resulted from its funding support."

Members of both the school system staff and the university faculty agreed that the corporation's role had been fitting and appropriately limited. While they would not have accepted any attempt to influence the structure or content of the curriculum, they welcomed the corporation's support and were enthusiastic about its apparent willingness to fund similar institutes in the future.

In fact, the role of the corporation in the three institutes' initial stages was critical to their existence. The city's superintendent of schools and the senior executives of other corporations had been exploring the possibility of a partnership for the improvement of the city schools for some time.

The corporation that became the institutes' funding source asked the superintendent to indicate the system's greatest need and assured him of support for whatever he identified as first priority. No doubt sensing the corporation's chief interest, as well as the city's critical need for additional science and mathematics instruction, the superintendent ranked first the system's need to retrain teachers from other fields in science and mathematics, and the attempt to meet that need then became the focus of the institutes.

In addition, the corporation itself asked the university in which the institutes were held to carry out an evaluation of their success. If the assessment, to be made during academic year 1984-85, proves positive, the corporation plans to distribute a copy of the evaluation to its offices elsewhere, in anticipation that the summer's efforts may be repeated under corporate auspices in other cities.

In this one city, efforts to marry the interests of the schools and corporations were well under way by the time CBE was asked to assist the schools and the corporation that eventually emerged as the funder of this effort by serving as an "honest broker" among the principal institutional participants.

Elsewhere, the Council played an earlier and more central role. In some cases, because of previous associations with local school systems and foundations and corporations, in others at the invitation of one or another party, the Council introduced people from different institutions to each other, sought college and university partners for school systems, identified and secured local sources of funds, and sponsored initial meetings of prospective participants.

In a number of instances, the Council, failing to secure the participation of one university, sought and gained the involvement of another. In one city, no university that would accommodate the expressed needs of the schools was found, despite the willingness of local corporations to finance an institute, and efforts to offer a summer program had to be postponed.

In short, the Council, as catalyst and broker, actively sought to ensure the academic quality of its institutes and to arrange to satisfy the needs of the schools.

The Council's brokerage role was unusual. It sought to take advantage of its access to local institutions in order to promote local partnerships for the improvement of mathematics and science teaching. In doing so, it entailed some major formal responsibilities. It became the fiscal agent for most of the institutes, receiving grants from local funding sources, disbursing payments to institute participants, maintaining detailed financial accounts, arranging for audits, and preparing reports of the institutes to supporting foundations and corporations.

It organized a special advisory committee, whose members visited the institutes and met to review their accomplishments. Its staff was in frequent contact, by visits, correspondence, and phone, with those responsible for each institute. Above all, it worked to maintain the momentum of each local program. In return, it gained a modest offset to its indirect costs.

Senior officers of the Council are quick to insist that its participation, though critical to the creation of the institutes, was not essential to the success of any single one—but they also point out the advantages of its involvement. In addition to relieving the schools and universities of fiscal responsibility for the institutes and allowing those sources that funded institutes in more than one city to provide multiple grants through a single nonprofit sponsor, the Council's efforts conveyed other benefits.

The Council brought about direct communications between institute personnel and arranged an evaluation meeting for representatives of all institutes. It gained national publicity for local efforts. It provided evidence on a broad scale of the potential of public-private partnership for the schools, about which there has been an intense national debate. And through its advisory committee, it established a mechanism to review and evaluate the institutes and to promote improvement in future ones.

The institutes were inaugurated in part to establish or, where they already existed, to improve relations between community schools, nearby institutions of higher education, and local corporations, foundations, or other funding sources. There is general agreement that it is still too early to assess the strength and durability of these associations, and in fact several participants believe that, while one measure of success may be the continuing interest and support of foundations and corporations, "the acid test will be the kind of lasting relationships the schools and universities can forge."

But even if it is premature to try to evaluate the depth and the future of these links between schools and ouside groups, the benefits that each party saw in its participation can be identified. Generally stated, these involved a mixture of direct gains and fulfillment of community obligations.

Corporations and their foundations—and, to a lesser degree, contributing independent foundations—saw community good will as a powerful incentive to their involvement. A concern for positive public relations and contributions to a favorable public image motivated all of the firms identified with the 1984 institutes. So, too, did a more generalized concern for what is perceived to be the low state of mathematics and science knowledge among Americans—in both of which large financial and manufacturing corporations have a direct interest. While admitting that local branches of a national corporation were not likely to benefit directly from improved mathematics and science teaching in a single city, one corporation officer argued that an increase in the mathematics and science competence of students over the long run would strengthen the skills of potential employees nationally.

College and university faculty members expressed somewhat sharper institutional interest in the institutes. Not only were they participating, as one said, because "it was the right thing to do" and because they genuinely desired to use their resources to improve the knowledge of school teachers, but they also saw the institutes as a way to spread information among school teachers about the colleges and universities themselves.

Some university officials believed that the institutes might help in recruiting freshmen. The admissions office of one university made a formal presentation to members of one institute during a regular afternoon assembly—a presentation, it was reported, that some teachers resented. In addition, the universities gained a contribution, through the grants that were supporting their institutes, to their normal operating costs, in every case modest and in most instances offset by the institution's contribution of faculty salary or by the waiver of teachers' tuition.

The public schools looked to the institutes as a direct contribution to their own mission. Many school officials hope that these initial programs will eventuate in partnerships that will yield support for the schools in other ways and in the upgrading of teachers' knowledge in other subjects. The teachers themselves often expressed the desire, sometimes the determination, to remain in touch with their faculty instructors and to seek their involvement and assistance in the work of the schools in the future. Whether these bonds and associations will endure is yet to be seen.

Perhaps most importantly, through its involvement in the initial stages of planning for each institute, the Council for Basic Education helped clarify the principal decisions that had to be made from the start. What were they?

## Planning Decisions

Foremost was a decision about the institutes' aims.

In planning for the summer of 1984, those involved in planning for all institutes seem readily to have agreed about the general purpose in view: the enhancement of teachers' knowledge and related skills. Nevertheless, at least four sets of alternative, corollary aims presented themselves.

One concerned the choice between, on the one hand, retraining those who held certification in fields other than mathematics and science, and, on the other hand, strengthening the abilities of those already experienced in teaching one of these subjects.

A second choice concerned the target group of participants, namely whether they were to be junior high or senior high school teachers or a combination of both.

A third set of alternatives related to the credit to be offered to participants—credit toward certification and recertification or toward a graduate degree—a decision that deeply affected the level and structure of each institute.

And finally, a choice had to be made between "seeding" many schools by admitting a single teacher from each, or admitting to the institute pairs or groups of two or three teachers from a few selected schools, in order to concentrate the benefits of the training.

Of these decisions about aims, the most critical was whether the purpose of an institute was to revive and stimulate the skills and vitality of teachers already experienced or certified in a subject, or to train teachers in a subject in which they had no experience and for which they were not certified. Clearly, the former approach is safer and, to some degree, easier.

The recruitment of practiced teachers with a record of experience related to the subject of an institute is a task with which university faculty members are more comfortable; the idea of selecting the least capable runs counter to their own aspirations and practice. School officials are somewhat less vulnerable to criticism should the results of retraining prove unsatisfactory. On the other hand, as an instructor in one of the summer's retraining institutes remarked, "You are starting with something closer to a blank slate in the teachers whose field is to be changed. The chief enemy is anxiety, especially of math."

In the absence of reports about teacher adjustment after the institutes and about the success of follow-up sessions, the record of the summer of 1984 provides no conclusive evidence, one way or the oth-

er, about the relative merits of retraining and enrichment.

In one city in which both mathematics and science institutes were devoted to retraining, instructors observed that they were favorably impressed with the ability, determination, and progress of the teachers they taught and that they found obstacles to their instruction fewer than they had anticipated.

In another city, the institute director, a member of the university's science and education faculty, whose efforts were directed to strengthening the knowledge of experienced science teachers, encountered many more difficulties. Anticipating the shortcomings of the teachers to be serious, she now thinks that "they are more so." It required all of the two-week program, "with great patience and forbearance," to overcome the teachers' hostility, she said. This instructor found the teachers' level of knowledge to be that of most "middle-level high school students." (Her associate, "astounded at how badly the teachers were prepared in the basic sciences," taught at a level below that of his regular undergraduate courses.) Like high schoolers, the teachers suffered from "serious problems of disinformation," the instructor said. All of this made for a sometimes sullen and combative classroom.

"How can she teach us experienced people how to teach science?" was the question that represented the teachers' attitude, according to the professor. Only after much work was she able to make the teachers aware of the limits or mistakes in their knowledge and to lead them to a greater interest in learning science for themselves—that is, to have a "greater intellectual engagement" with the subject.

Thus, if experience is to be our guide, the decision about the purpose of an institute—preparation in a new subject or reinvigoration of an old one—should probably be based upon an assessment of local needs rather than upon anticipation of greater or lesser success or ease. The troubles and gains, though of different sorts, are similar in the two kinds of approaches, and teachers appear to benefit in both.

Another set of decisions, all in some way affecting the manner in which the school system and the participating local college or university would cooperate, concerned the announcement of the program and the selection and orientation of participants. The issues surrounding these and all other aspects of each institute are reviewed in subsequent sections of this report.

It should be emphasized here, however, that only a very few of those responsible for planning institutes gave early consideration to the orientation of participating teachers between the time of their admission and that of the institute's first meeting. As a result, said more than one faculty member involved in an institute, "The early classes came as a shock to the teachers. They didn't expect what they got, and as a result time and energy were lost in complaints, anxiety, and sometimes anger."

Decisions about stipends, credits, and other incentives proved also to be a critical dimension of the planning process. So, too, of course, were those concerning the curriculum and faculty. In this matter, views of the college and university faculty members usually carried the greatest weight; yet, as many institute directors observed, the contribution of school officials—and, many insisted, of teachers themselves—was essential in providing a grounding in the realities of school teaching and life, in which many faculty members were inexperienced.

Finally, decisions about the evaluation of the institutes and about follow-up activities had to be made. A review of all of the institutes in general warrants the conclusion that these were the two weakest aspects of the planning phase. Consideration of ways to measure the effectiveness of an institute, to maintain its momentum during the school year, and to embed its results in enduring inservice programs was undertaken in most instances very late in the planning process or haphazardly. Even by the end of August 1984, some plans for follow-up activities had not yet been precisely formulated. Equally notable was the absence of evidence that the school systems planned to use the newly trained teachers in any systematic way to convey to their colleagues what they had gained in the institutes.

## A Special Case

The principal exception to the efforts of institutes to strengthen the existing skills of mathematics and science teachers took place in a district in a state that had recently mandated by state law an increase in secondary school mathematics and science requirements.

The local superintendent, not unmindful of the likelihood of corporate support for teacher education in fields related to corporate interests, believed the needs of science and mathematics education to be the highest priority in his system. In response, the three summer institutes there gave preference to those who were neither certified in, nor currently teaching, mathematics or science. Only after applicants who met this requirement had been admitted did the institute turn, first, to teachers holding temporary certificates in mathematics or science and then, second, to teachers fully certified in one of those subjects.

Because of the distinctiveness of their purposes—to retrain, rather than to upgrade the existing skills

of teachers—these institutes invite special attention here.

The district, the local funder, and the associated university were motivated to this distinctive approach, despite its risks, for a number of related reasons. Obviously, there was need for more mathematics and science teachers to meet the new curriculum requirements, and to replace experienced teachers who were leaving the system. But in addition, a comparative decline in curricular importance of such subjects as music, vocational education, and physical education accompanied the new emphasis on mathematics and science, and many experienced teachers in those fields were threatened with loss of employment. Fairness to teachers facing unemployment made it appropriate, the district believed, to offer opportunities for retraining to any of them who wanted to remain in the school system and who were willing and able to undergo the rigors of field-switching.

Everyone knew it was a risk. "My *a priori* estimate of success for such a program," wrote the Council's evaluator, "was very low." Prospective applicants, probably already demoralized, seemed "unlikely prospects to become excellent teachers. Forcing them to switch or lose their jobs hardly seemed likely to improve their attitude toward learning or teaching."

Nevertheless, he concluded after visiting and reviewing the institute, "I believe this program for recertifying teachers of other subjects to teach mathematics has as high a probability of turning out good mathematics teachers as any reasonable program I can imagine."

Others agree. Said the district supervisor about what he acknowledged was a "high risk group," the mathematics and science institutes went "much better than anticipated." The principal mathematics instructor concurred. He had "never had a class that put forth this effort." An instructor in the institute thought the test was whether he could turn people in a short time into mathematics teachers. He is convinced, he now says, "that 50 to 60 percent of them will make it."

Over 100 teachers applied for the mathematics program alone, of whom 50 were selected to participate. After discussions with advisors and a realization of the magnitude of their prospective endeavor, about 10 declined to accept admission. Roughly five more dropped out after the start of the institute. The 10 who never registered were replaced by instructors already holding temporary or permanent mathematics certification.

Of the 25 admitted to the science institute, none left. Institute leaders and district officials believe that the record reveals the strength of teachers' desire to remain in the classroom and the viability of retraining, about which they admit many have doubts.

To what do they attribute the low attrition and the apparent success of these two institutes? No single factor, the district superintendent insists, explains either. Many teachers simply wanted to retain employment in the city's schools and would go to any decent lengths to do so. Many "just really wanted to broaden their background." For some, the comparatively handsome stipend—$1,350 for a four-week institute, $400 more upon the completion of two regular semester-long courses at the local university, and credits toward state certification—helped.

School officials cite the skill and commitment of the institute faculty, who recognized and adapted to the special needs of the teacher-students and to the differences between them. (It was in one of these institutes, for instance, that the director gave the teachers his home phone number and made himself available by phone until midnight.) Another key appears to have been the presence of skilled teaching assistants, "master" teachers in the district, who seemed to the teachers, especially at first, to be more approachable about their problems and fears.

An important ingredient in the program's success was the district's participation in the selection of teacher-students. Especially useful was the assistance of teachers' supervisors in helping to identify teachers uncertified in mathematics or science who were the strongest candidates for a successful switch of field and a move into new responsibilities.

It was accepted from the start, for example, that, since the target group was composed of those who possibly lacked even college courses in mathematics and science—or, if they had ever taken any, had enrolled in them some years ago—few of the students could be certified after a single summer of retraining. Additional and follow-up programs would be necessary. The recognition by everyone—most critically, by the students themselves—that a single summer's work would not suffice helped greatly, in everyone's view, to sustain morale and contribute to a realistic program of activities.

Another, less apparent reason for the success of these three retraining institutes may have been the clear and clearly fair and demanding expectations presented to applicants and those admitted, right from the start. After participants were selected, those with too much academic background or those who seemed to have applied simply for the stipend were screened out.

Admitted students were then required to attend a briefing meeting as a prerequisite to participation.

(Only one successful applicant was excused, for unavoidable surgery.) At the meeting, they were told that the institutes were not designed to provide "bandaids on a career." They learned that hard academic work was expected; that they would feel pressure, perhaps anxiety (one instructor knew that well; he held a high school teaching certificate himself); and that they would have to struggle to change themselves into mathematics and science teachers.

Then, to drive home the point, the institute directors required all prospective participants to notify them within three days about their decision to attend or not to attend. It was at this point that some attrition occurred in the mathematics institute. For those who remained, the process appears to have strengthened their commitment to difficult work.

It is not clear that these institutes' teacher-students differed sharply from those participating in institutes devoted principally to upgrading the abilities of those already teaching in the field. For example, one teacher in an institute of the latter sort had been teaching mathematics for some time but was not certified to do so. She had been involuntarily transferred from teaching upper-level social studies to a lower-level class in which she was required to teach mathematics. In addition, many participants had been away from serious study of science or mathematics for over 20 years. In one school district, it appeared that only two or three of the teachers teaching seventh and eighth grade mathematics had been mathematics majors in college. Similar problems, similar challenges existed in all institutes.

## CHAPTER 2

# *Recruitment, Selection, and Orientation*

Decisions about the kind of curriculum to offer and hence about the kinds of teacher-students to attract—whether those in need of retraining or those who would benefit from enrichment—were only preliminary to the initial, and critical, administrative task of attracting and selecting participants.

During the spring and summer of 1984, everyone subsequently agreed, the chief elements in the selection process were:

- announcing the institute;
- clarifying its aims;
- deciding the stipends and incentives to be offered;
- selecting the participants.

Many means were used to announce and publicize the institutes. All worked to some degree. None was foolproof. In a number of cases, a serious obstacle to the distribution of information about an institute turned out to be a school principal. In every instance, no single means was enough.

### Announcements

The crucial ingredient of the announcement process turned out to be putting information about an institute into the hands of teachers. As one institute director put it, "Everything had to be tried."

Many methods were adopted in 1984. Some institutes issued attractive printed brochures; others xeroxed typed flyers. Intended to provide basic information about an institute to potential participants, these announcements were distributed to individual schools, usually through principals' offices.

Sometimes the announcements didn't reach individual teachers. Some ended up on bulletin boards; in a couple of instances, they never left the principal's office. (One director in a relatively small school system, anticipating the problem, secured a list of all the mathematics teachers and wrote to each one individually at home.)

The principal, as usual, became the critical switching point for information. Some school superintendents sent special announcements of the institutes and included information in periodic newsletters to principals.

More than one superintendent devoted a portion of his monthly meeting with principals to a discussion of the institutes.

One institute director took matters into his own hands from the beginning. Because funding was secured only in mid-April, and because many teachers were already committed to summer employment or other education programs, he had, as he put it, to "really pull out all the stops." He took it upon himself to address letters to the principals and mathematics department chairmen in each of the city's junior and senior high schools, and he spoke before a systemwide meeting of department chairmen.

After receiving only 14 applications in two weeks, and with only two weeks left before the applications deadline, he visited the superintendent and other school officials. Exasperated by what he felt were merely polite assurances of support and an apparent preference for computer-familiarization as an inservice for teachers, he wrote another letter to school principals emphasizing (perhaps disingenuously, he admits) that the institute had the superintendent's complete backing.

He then sent a copy of the letter to each board member, and extended the application deadline for two more weeks. Evidently, he reports, his continued intervention bore results. Eighteen more teachers applied.

Not all institute directors faced these obstacles. In one large jurisdiction, due in large part, the director argues, to the enthusiastic support of the school system and especially of its mathematics office, 400 teachers applied for 25 spaces.

Once adequate publicity was gained and information distributed, questions from prospective applicants had to be answered. One institute director was astonished at the kind and level of inquiries he received, most of which, he insists, were dealt with in the program announcement. Another, less surprised, put an answering machine on his phone, took all inquiries, returned all calls, and by doing so, he is convinced, not only increased the number of applications but also set at rest the many apprehensions about returning to serious college-level study that, unaddressed, would have deterred many teachers from applying.

His advice? "Keep a telephone line open. Be patient. Answer all questions. Expect to spend time on this. And realize that these efforts commence the process of creating or restoring the confidence of teachers who haven't studied seriously and hard for years."

What should the program announcement contain? No one disputed the need to set forth with clarity and care the aims of an institute; by what means it would seek to achieve its goals; who was eligible to apply; the dates of the institute and the hours of required attendance in class and in other, especially follow-up, activities; requirements for application, the manner of selecting participants from applicants, and the date of notification of selection; and stipends and other benefits.

But there were varying views among both participants and institute directors about whether prospective applicants should be alerted beforehand about the amount or intensity of work to be expected during an institute. "That will deter them from applying," said one. "It is the only honest thing to do," said another, adding that "it would attract the most dedicated and energetic teachers." As it turned out, none of the institute directors realized in advance how out-of-practice in classroom and homework study the large majority of teachers were, and therefore they did not make special attempts to alert applicants to the effort that was to be required of them.

## Applications

An important dimension of the application and selection process was the application packet itself. Application forms differed considerably in the amount and detail of information required. Most of those involved in the selection process agreed that, at the very least, a record of each applicant's education, especially of courses taken at the college level in subjects related to the institute, and of the applicant's teaching experience, again particularly in the institute subject, was essential to a complete application.

A statement by the applicant's principal was also solicited in every case. But because experience showed that many of these endorsements were of limited value, some directors urged that principals be required to comment specifically on certain points, such as the applicant's quality as a teacher, the perceived benefit to the school of the teacher's participation in the institute, and the use to which the teacher's new or revived skills and knowledge would be put. A few project directors commented that solicitation of a full recommendation from a principal, instead of a perfunctory endorsement, was one way of gaining the principal's attention for the institute and committing the principal to make appropriate use of the teacher's new capacity on his or her return to the classroom. They also recommended that an application contain recommendations from an immediate supervisor and from a third person of the applicant's choice.

Some instructors involved in the selection process remarked on how little they could tell of a teacher from an application. Acknowledging this to be the normal frustration of any admissions process, one instructor nevertheless said that he regretted not having had a statement from each applicant about why he or she wished to participate in the institute, what the state of his or her own knowledge of the subject was, and what he or she expected to do with heightened knowledge and skills at the conclusion of the institute.

## The Selection Process

As the announcements of an institute led to applications, so the application process eventuated in selection and admission. The varying interests at stake, some of them complementary, others competing, rendered all of the selection procedures, however generally successful in the end, imperfect; and as they always seem to do, the processes raised questions of impartiality and equity. Fortunately, none of the issues which emerged seemed serious, and in no instance did the selection process appear to have been compromised. The potential for problems exists, however, and should be guarded against.

As with other aspects of the institutes, the selection process varied among them. In most cases, it brought together representatives from the school systems and members of the institute faculty, usually the director.

In those instances in which applications only barely exceeded the number of spaces available, selection decisions were not arduous, for the inclination was to accept all but the weakest applicants on the grounds that no opportunity to enrich the knowledge of any teacher should be lost.

Those institutes that attracted many more applicants than spaces available were in the most advantageous position. They also had the most burdensome task. Nevertheless, when selection panels were of the right size and mix (involving both school people and university faculty), and when time was set aside for careful choices, the selection process generally proved no more onerous for these than for other institutes. One director thought, however, that, ideally, each applicant should be interviewed. He admitted that would make the selection process much more time-consuming.

Those few faculty members who operated alone in selecting students, while recognizing that assistance from the school would have been helpful, were satisfied that they had done a good job. Faculty members who played no role in selection but were required to accept students selected for them by others were understandably more critical: one raised the issue of possible conflict of interest, arguing that school officials might show favoritism or select participants for reward, rather than need or merit.

One school system that did not involve any university faculty in the selection of institute participants was apparently sensitive to the problem and placed four curriculum specialists from as many schools on an advisory committee that helped choose teachers and their alternatives. Those institutes that excluded college and university faculty members from selecting participants justified their approach with the argument that the schools knew the teachers best and could identify the skills that might be used in future inservice programs. When confronted with this reasoning, a university faculty member retorted that his presence would not have prevented consideration of such qualities as inservice skills; it would instead have "broadened the discussion to include consideration of such factors as prior education and experience and ability to undertake intensive work."

One instructor—arguing for an all-out effort to generate applications—pointed out that if the number of applicants is inadequate, the "mix" of students, from weak to strong, will be great, and the institute will consequently be harder to teach. One institute faced and solved this problem by dividing the institute group into two sections, thereby doubling the teaching load of one instructor.

A problem frequently remarked upon by institute faculty members was the proportion of teachers selected for admission who failed even to respond to notices of acceptance. In one case, one-fourth of those accepted for an institute failed to notify the director of their decisions. This makes it necessary to provide careful follow-up, he said: "Passivity has to be met with activity."

Most institutes selected participants individually. In practice, this simply meant that teachers applied to institutes as individuals and were admitted without regard to the schools in which they taught. By this approach, it was reasoned, the most qualified applicants would be selected. As it turned out, in only a few cases was more than one teacher from a single school selected to participate in an institute.

A few institutes, however, chose teams of teachers to participate together. The team approach, while making no concessions to quality, rested on the assumption (not yet validated) that a greater impact on an individual school would result from concentration of two or three returnees from the same summer institute. In one city, the 30 institute participants represented 11 two- and three-person teams from as many schools. Each team was composed of a teacher from the first and second grades, the third and fifth grades, and the seventh and eighth grades. (One person suggested that the principals of the schools should have been involved, too.)

How was the selection of the teams carried out? Schools in the district submitted to the superintendent's office applications for the teams of nominees. District officials then selected the schools whose teachers were to participate on the basis of geographic distribution, the experience and quality of the teachers, and the specialties, if any, of the applicants. The institute director played no role in the selection process in this case.

## Orientation

The final stage of the application and selection process was the orientation of teachers who accepted admission to the institutes.

Very few of those involved in planning the 1984 institutes gave adequate forethought to orientation, instead leaving an introduction to the content and rigors of instruction to the initial institute sessions. The directors of most of the institutes that offered no preliminary review of their aims, curriculum, and procedures concluded that the early meetings of classes provided sufficient opportunity to expose teachers to the institute's expectations and requirements. Some argued that, since some confusion and anxiety were bound to exist anyway, those problems could best be faced in the situation of the institute itself and required no preliminary address.

Others disagreed. One institute even made attendance at an orientation session a condition for admittance to the institute proper. The purpose of a separate orientation meeting, according to those who convened one, was to make certain that all anticipated participants understood what was expected of them and to reduce attrition during an institute.

As one faculty member observed, preparing teachers for, and thus cushioning, the shock of the first encounter with new and difficult material "simply reduced the number of those who left the institute." Furthermore, he added, with a list of alternates available, any attrition caused by the orientation session itself allowed him to admit some from the waiting list of applicants. "It was the responsible thing to do," he argued, "especially for the alternates."

Another reason cited for early orientation was to provide teachers a chance to express their fears or to vent any hostility they might feel about the institute, its aims, and its approach.

Without reported exception, however, it seems that orientation sessions did not fully eliminate initial anxiety and perplexity. The most that can be said is that they somewhat lessened participants' difficulties at the outset of an institute. Those institutes that convened no orientation meetings simply faced the issues later and in somewhat greater degree.

## CHAPTER 3

# *Curriculum and Instruction*

Nothing marked the 1984 institutes more than their curricular focus. A majority, especially of the mathematics programs, adopted a problemsolving approach, emphasizing instruction in how to solve the kind of mathematics and science problems high school students encounter.

Some institutes offered a more academic curriculum—classroom lectures and demonstrations in the theory and application of basic subjects, such as advanced algebra or physical chemistry, combined with some practice teaching of those subjects. A small number in the sciences presented college-level lectures, often by senior researchers in their fields.

Discussions about the appropriate approach depended upon the aim of an institute, the perceived needs of the school district, and the experience and qualifications of the enrolled teachers. Although, with experience, some instructors would have altered their emphasis to some degree, none was displeased with the method he or she had adopted. Nor did any of the difficulties encountered in the institutes appear to originate in the instructional approach.

### The Curriculum

Once the aims of an institute were established and a curricular approach agreed upon, it was left to the faculty instructors, principally the directors, to determine the specific curriculum and contents of an institute. As one said, he "would not have had it any other way." Yet all seem to have been sensitive to the priorities of school officials and to the needs and knowledge of teachers, and to have responded to both.

Naturally, curricula varied from institute to institute. In those that emphasized problemsolving methods in mathematics, lesson plans could easily and rapidly be altered, and often were, in response to teachers' needs and difficulties. In institutes, especially in the sciences, in which lectures by invited guests were frequent and the purpose was to introduce participants to a range of scientific subjects, changes in the curricular plans could less easily be made. This was also true in those mathematics programs designed to expose teachers to theory and history, as well as to problemsolving.

The faculty of one institute developed a full curriculum, prepared an extensive syllabus, sent a copy early to all applicants to the institute, and then, finding it far too difficult, had to scuttle it. "We learned our lesson," commented the director. Nevertheless, he argues, the idea of preparing and distributing a syllabus prior to an institute has much merit, and he would do it again.

The curriculum and its variability depended to a large degree upon the academic level of the course. If the college or university preparing the institute intended to offer college credit for it, the institution's own requirements for coverage and intensity had to be met, and alterations could be made in detail but not in major substance. (One university declined to offer an institute after the school system and the university could not agree on the contents and level of the curriculum.) Where an institute carried only recertification or analagous credit, faculty instructors could more easily develop the curriculum as the institute progressed.

One aspect of the curriculum—practice in the use of computers—caused controversy in almost every institute in which it was a factor. No general views about the appropriateness, scale, or method of computer instruction are shared by those whose institutes offered it. Participating teachers themselves were of widely differing views, some enthusiastic at being introduced to the computer, others feeling it had diverted them from other more important tasks.

As one instructor said of his own institute, the problem was that when computer instruction was taking place, "the effect was that essentially no mathematics was being taught."

In every case, hand-held calculator and microcomputer practice was offered as a means to problemsolving. That this purpose, and only this purpose, should govern the computer's use in institute instruction won unanimous consent from institute faculty members. However, because, as many pointed out, there existed such wide discrepancies in the computer experience among teachers, much time had to be spent, even in the few hours allotted to computer-assisted problemsolving, simply familiarizing the inexperienced with the computer. In one institute, the participants were divided into two computer sections.

Faculty members offered more warnings than expressions of satisfaction when speaking of the computer. Avoid all lecturing about computers, urged one; "have it only hands-on work." "There should be no writing of software," insisted another. Make certain that the faculty offers instruction, cautioned another; representatives from computer companies will only talk about what computers, and only their computers, can and will do.

One director noted that computers increase the anxiety level of some teachers, while another argued that some of those inexperienced in computers might be attracted to an institute not because of its content but because of the chance to learn computer techniques.

Above all, warned a member of the Council's advisory committee, remember that "At most you should be familiarizing teachers with the computer. You should not teach them to program nor to teach children to program. That's the last thing that kids need to learn to do! They need to learn, first and foremost, to do math."

## Instruction

The institutes demonstrated greatest diversity in the length and schedule of instruction. This report can do no better than to relate this diversity by example.

One mathematics institute convened for four hours each afternoon for three weeks. Its focus was on algebraic functions, some attention being paid to teaching techniques and the use of microcomputers. The institute instructor, a senior member of the mathematics faculty of the participating university, had taught both teachers and children before and therefore sought to have the teachers appreciate how children's mathematics skills develop and how to avoid presenting materials at odds with children's experience and level of development. He did not prepare a specific curriculum, preferring to develop subjects as the teachers' difficulties and interests made themselves known. Yet he had selected some basic topics and was prepared to move to others as opportunities arose.

"We had to move fast," he reports, "and there was never enough time." His teacher-students agreed. Yet from all accounts, the institute challenged everyone and sharply raised both knowledge and skills.

The instructor first presented some problems on, say, fractions, but in a way that was out of context for the teachers, so that all came to the problems fresh and on an equal footing of puzzlement and discovery. All of the teachers knew fractions, but little of the reasoning behind them, their use, their rules, and their versatility. It was at this point that the instructor introduced problem sheets or teaching aids, such as Cuisenaire rods or geoboards, that are often in the schools' possession but are rarely used.

One teacher remarked on her pleasure in using these "materials that often lie around in closets gathering dust. I didn't even know what they were for." Moreover, she said, "being put in the position of students gives us a much better idea of what kids feel like and face" and about "different styles of learning," such as talkative and silent problemsolving. (An observor remarked to one of the teachers in the midst of an especially noisy problemsolving session that he knew she would never have tolerated such commotion among her own students; she said that now she'd have to think it over.)

Many of the teachers testified to the degree to which this approach, coupled with the organization of the class into groups of roughly five people around tables, helped reduce their own insecurities and phobias—which, as one was quick to point out, get passed on to their students. Many described the "excitement" they felt, and their "surprise" at their own pleasure.

The team approach gave each a similarity of problemsolving experience and a buttressing of confidence—as did some modest homework assignments—as all the students together faced the same difficulties.

Some, previously fearful of springing free of the "security blanket" of a textbook, found the concrete problemsolving and investigative approach novel and at first "frightening." But quickly, they said, they became comfortable with it and were looking forward to developing their own problems and passing their new-found ease on to their students.

"After all," one said, "texts often have the answers but not the solutions. Now I'll trust my own ability to develop one or more solutions to a problem."

"We pass on our own greater comfort with the subject," another said, "as a comfort to the kids."

A second mathematics institute for 30 junior and senior high school teachers ran seven hours a day for five weeks. More theory-oriented than the institute just described, its 150 hours of instruction were divided between roughly 125 hours of classroom discussion and 25 hours of application.

A typical day commenced at 9:00 a.m. with a 90-minute lecture in the history and philosophy of mathematics. After a half-hour break for coffee and donuts (which, many institute leaders report, is essential for building *esprit* and giving teachers the sense that they are being treated as professionals), an hour was spent, often under the direction of a second instructor, discussing the problems posed in the previous night's three hours of homework. After an hour and a half for lunch, during which much work also went on, the larger group was divided to work on problems and to give oral presentations of the homework, during which those making reports had to explain and defend their solutions.

Although some resistance to instruction in mathematical theory was evident in both the teachers and the school district, the chief instructor is confident that "the teachers' math juices are flowing again." Others were not so sure. The university offered college credit for the institute, which explains the inclusion of instruction in theory and philosophy. This element, coupled with the institute's emphasis upon problemsolving and inclusion of some calculus, resulted in fewer applications than were sought (though this was due in part to administrative confusion) and to some attrition (eight of 30 original students dropped out), and to a preponderance of high school teachers when a mix of middle and high school teachers had been desired.

The district's supervisor of mathematics believes that the greatest problems exist at the junior high level (in areas of fractions, integers, decimals, tables and graphs, and algebra) and predicts that a future institute will have to surrender college credit in the interest of more practical and appropriate instruction, especially for junior high school teachers.

A third mathematics institute sought to enroll 30 seventh and eighth grade teachers for intensive instruction six hours a day for two weeks. Due to confusion regarding the reimbursement of teachers' individual payment of tuition, only 17 registered for the program. During six hours of instruction, in addition to which they received nightly homework assignments, teachers met in three two-hour sessions.

In so short a program, the instructors sought principally to give the teachers a "flavor" of algebraic, logical, geometric, and computer problems. They did so by dividing each two-hour session into segments in which the two instructors alternated in presenting different aspects of a problem or function, and the teachers, with the aid of teaching assistants, then tried their hands at problemsolving.

Some students preferred one instructor's practical approach, while others, most of whom had taken courses at the university, were more comfortable with the second instructor's more theoretical approach. Most of the teachers were disappointed that more attention was not paid to teaching methods—which will be the focus of school-year follow-up sessions. Yet most overcame some mathematics anxiety, due in large part to discovering, in the words of one faculty member, "that there are many ways to state things mathematically and alternative ways to teach the same concept."

The result, he says, is a restoration of confidence in all the teachers—testimony to what even a brief immersion in the subject can accomplish.

A fourth mathematics institute ran for four and a half hours per day for four weeks. It was broken into two segments, one from 9:00 to 11:30 a.m., the second from 12:30 to 2:30 p.m. The director worked only on problemsolving and did so by assigning three kinds of problems—what he called "quickies," which could be solved on the spot; daily problems, which were more difficult and required discussion and demonstration; and weekly problems, which forced teachers to think in "a creative way about fundamental problems in mathematics" (such as Euler's theorem). He began each day with a lecture on some aspect of the weekly problem, and then the class devoted the rest of the work day to solving the daily problem.

The first week, in the words of one teacher, was "traumatic." She had not thought seriously about mathematics in 15 years. Yet, said the Council's evaluator, who visited the institute toward the middle of its term, all of the teachers were "reaching" for skills and were clearly enjoying themselves. Another teacher said that she had shared her students' fear of putting the text aside, but problemsolving practice had "raised my confidence level" and "allowed me to think of weaning myself from the textbook." Another was awakened by the concentration on problems, he reports, to students' fears of mathematics and to the fact that instruction in the subject is as much a verbal as a numerical and reasoning skill.

A fifth mathematics institute ran for three weeks and included 12 afternoon microcomputer laboratories taught by a master school teacher. The program, more structured than many, was based upon a syllabus designed in late winter and distributed to all

applicants. (It was this syllabus that had to be sharply modified and made less ambitious soon after the program commenced.) Occasionally during the institute, other instructors from both the schools and the university offered lectures. The leaders of the institute were sensitive to the danger of overusing computer instruction, insisting that in many instances it prevents experimenting in different problemsolving methods. Yet even given the instructors' care and their awareness of dangers, many teachers found the computer sessions dreary and had a difficult time even becoming comfortable with the use of hand calculators.

Another mathematics institute, associated with two science institutes, met for six weeks, five days a week. Its contents mirrored those of the institutes previously described, except that it offered more instruction than most in the use of computers and was confronted with wide discrepancy in computer familiarity and skills among participants, which required division of the group into two sections. One evaluator reported that the time spent in computer instruction to aid problemsolving work had the effect of seriously reducing the time spent in teaching mathematics.

The science institutes were similarly varied. One ran for two weeks and covered three major topics in the physical sciences: classical mechanics, fluids, and heat and temperature. In order to correct what they saw as lack of basic knowledge and also serious misinformation on the part of teachers, the instructors adopted a method of iteration and reiteration. Three days were spent on each topic area. Each three-day segment commenced with a test, handed in anonymously, to give the teachers an idea of what they knew or did not know, to let them begin thinking about the topic, and to give them a sense of the level of its difficulty and complexity. Then participants went over the test together with a fresh copy. There then followed three hours of lecture, demonstrations, and discussion. In the afternoon, another member of the university faculty lectured and led a discussion on the same subject—this being the teachers' third exposure, though from a different perspective, to the same problem.

On the second day of each three-day segment, teachers worked through laboratory exercises—which the school district, wishing more classroom emphasis on laboratory instruction, had required to be part of the institute. The teachers then wrote up their laboratory experiments, explaining how they would use the experiment in their high school classes and what changes they might make in its presentation. On the third day, teachers presented their experiments in a lecture-demonstration to the group.

Probably because of its brevity, instructors in this institute believe that teachers will not venture far in their teaching beyond the subjects that they covered during the summer or the laboratory experiments they carried out. One university lecturer, however, was sure of one thing: the teachers, he said, "would never go back to class feeling confident that they were knowledgeable in the subjects they had *not* studied." That is to say, "humility would make them more objective."

Another science program, extending for five weeks and limited to the biological sciences, combined lectures with laboratory work, curricular development, and lecture-discussions with some of the nation's leading biological scientists, drawn from a major independent research institute nearby as well as from the university where the program was held. Since the biological sciences are now so multifarious, the topics chosen for coverage were those in which there had been major or revolutionary advances since the teachers' undergraduate education and those—such as cancer, virology, immunology, genetics, and genetic engineering—in which it was assumed that both teachers and their students would have a lively interest. After morning lectures and discussions, often with distinguished scientists—the sessions often lasting until noon, beyond their normally alloted 1 1/2 hours—the teachers, working in teams, would translate the morning lectures and discussion into teaching materials (such as slides), demonstrations (such as those to be carried out on field trips) and experiments. They also presented materials to the group for criticism and then prepared their presentations for inclusion in a workbook that is to be produced after conclusion of the institute.

One physical science institute that explored astronomy because faculty members were interested in that field met some criticism for its curriculum. Teachers learned much but feared that they would not be able to teach the subject in the schools. "Next year," said its director, "we will not make this error."

## Teaching Assistants

The differing experiences and perceptions of the college and university institute instructors, on the one hand, and the teacher-students, on the other, seemed from the start to require the aid and mediation in each institute of at least one teaching assistant drawn from the school system.

Often "master" teachers of some sort, sometimes already holding some kind of supervisory responsibility in a school or in the school district, teaching assistants were expected to help the other teachers, in a word often used by participants, to "translate" the contents of classroom lectures and problemsolv-

ing activities into forms and activities appropriate for use in the classroom. As one assistant put it, "The faculty members taught teachers how to solve problems. I helped to teach teachers how to teach to solve problems."

The assumptions governing the employment of teaching assistants—said by all faculty instructors to be correct—was that professors were too ignorant of or unpracticed in secondary school class instruction to teach a class of high school teachers effectively alone. In every case, the presence and involvement of at least one school-based teaching assistant was said to be critical to the success of the institutes.

Teaching assistants were recruited in a number of ways. In some instances, institute directors selected people already known to them, either as graduate students or as acquaintances from other projects. In others, the superintendent's office chose the assistants, all of whom had served in similar capacities before, to work with faculty members without soliciting applications. One director selected an assistant on the basis of a resume and a phone interview—a risky procedure—and found the choice "perfect." Another selected assistants after interviews of those "nominated" by the school district. In one institute, which employed three assistants, two were senior or supervisory teachers in the school district who were unknown to the institute director, while the third was a former teacher now studying for an M.A. with the director and preparing to return to the classroom. As in other aspects of the institutes, it seems preferable that assistants be both experienced in instruction and knowledgeable in the subject of the institute and that they enjoy the confidence of both the district leadership and the institute director.

What did assistants do? Everything, it seems. Unlike instructors and lecturers, who stood before the classes to teach, and the students, who sat to listen and practice, the teaching assistants sat and learned with the teacher-students, taught with the teachers, and roamed about in-between. They identified and aided teachers in difficulty, ran sessions in which teachers discussed how to apply their new knowledge to classroom situations, directed some laboratory sections, and offered instruction on the application of computers to problemsolving. A few participated in planning the institute and designing the curriculum. One ended up with the responsibility of gathering the curricular materials developed during the institute by participants and preparing them for production and wide distribution as a workbook for use by other teachers.

In the view of members of the Council's advisory committee and occasionally of those responsible for institute leadership, teaching assistants in a couple of cases were not utilized as well as they might have been, their function being limited largely to passing out materials, operating the overhead projectors, and collecting completed problems.

As one of the Council's advisors observed, assistants were most effective when charged with helping small groups of teachers involved in laboratory projects or mathematical problemsolving to work together and to attack problems and assignments. Reviewers were in agreement that assistants must be given clear and active roles, should be experienced teachers who know the frustrations of learning as well as of teaching, and should be selected only with the agreement of both the school district and the institute director.

Institute faculty members unanimously judged the participation of assistants to be indispensable, their work of the highest quality. Most observed that their institutes could not have succeeded without assistants drawn from the schools.

As for the assistants themselves, all concurred in the conclusions of one of them. His presence, he said, kept the institute from being a "regular college course." He kept it "on the ground." Without his daily involvement, he concluded, the faculty members would have taught over the teachers' heads, and many of the latter—already struggling with the material and not yet confident of their abilities to enjoy and master it—would have dropped out of the institute from demoralization.

## CHAPTER 4

# *Incentives and Stipends*

The experiences of the 1984 institutes do not provide a reasonable test of the incentives offered because in almost every instance the application process commenced so late in the school year. Therefore, as many people reported, many potential applicants had already made other commitments to paid employment or other summer educational plans. A few—but only a few—failed to enroll after being selected due to having accepted other offers. However, it is possible that the potential candidate pool was reduced in some cases by the employment elsewhere of those who made early plans or sought more substantial summer income, thus increasing among applicants the proportion of those for whom an institute was the last resort.

The incentives to participation offered by the institutes were on the whole similar. Those differences that did exist did not seem appreciably to affect the number of applications or enrollments, nor to substantiate fears that participation would be sensitive to "market" forces. Nevertheless, it cannot be assumed that future applications and matriculations will not respond to the nature and level of benefits, tangible as well as intangible, derived from summer institutes.

The chief variable in the normal package of incentives was the stipend, which varied from $360 for a 10-day institute (governed by union wage rates) to $1,350 for a four-week program plus $400 for the completion of a schedule of follow-up activities during the 1984-85 school year.

In addition, every institute covered the cost of participants' tuition at the college or university offering a program (which in some cases waived tuition altogether) and contributed all books and other materials needed for study, transportation to other sites for instructional purposes, and any computer time needed for instruction or practice (the cost of which was also sometimes waived by participating universities). One offered $300 worth of classroom aids.

In all cases, participants earned credit from their school systems toward certification, recertification, or other equivalency. Some but not all participating universities considered the institutes (especially those that offered the option of an exam and a letter grade) to be the equivalent of courses offered toward completion of a B.A. or M.A. degree, and one attraction of a few institutes was that they offered course credits free to participants. (One charged a modest $110 for four graduate credits.)

It is impossible to know how the level and combination of incentives affected applications and enrollents. One institute, paying (in addition to tuition, credit, and books) $500 for a three-week program—a low sum in comparison with most of the other institutes—also drew the largest number of applicants (400 for 25 spaces). Many participants in that institute considered the fee to be an adequate sum even when informed that more had been offered elsewhere. Only a few expressed dismay when told. None, however, not even members of the supervisor's staff, had thought earlier to compare the stipend with others or to question its size. Nor did the Council seek to propose or negotiate a uniform level of payment. In at least one jurisdiction, the size of the monetary stipend was governed by a union contract. In only one or two instances did institute directors report resistance because of the size of the stipend, and the number of cases of reported resistance remains too small for a conclusion that the financial award is a key ingredient in attracting applicants.

In addition to the amount of the stipend, the schedule of its payment must be considered as an incentive. In some cases, it was paid at the conclusion

of the formal institute in a lump sum. In others, a portion was tendered at the midway point, the remainder at the institute's conclusion. Some institutes retained a portion—in one, 50 percent of the stipend—for payment upon participation in the follow-up sessions planned for the fall and spring of school year 1984-85. The different approaches—determined in every instance by the district, not the institute director—were due to divergent views of the reliability and professional responsibility of the teachers—than which there may be no more sensitive and critical issue in American education.

Some believed that the teachers must be treated as serious professionals, paid in one or two increments in recognition of skills and dedication already demonstrated. Said one superintendent, "the real challenge is to convince teachers that an institute is a realistic alternative to other summer activities." Others tied compensation to attendance and participation, as rewards for work performed. A few institutes withheld full payment until the completion of follow-up meetings in the conviction, as one said, "that it was the only way to get teachers to attend sessions during the school year." Different views of human nature governed different approaches.

None of these views is attributable disproportionately either to school officials or institute directors, except for the sharp mistrust by one district administrator of teachers' dependability, a view he claimed derived from experience. Such a view is probably self-fulfilling.

Far more noteworthy is the fact that no teachers complained specifically about the schedule of payments. Instead, they expressed pleasure and satisfaction at being treated as coprofessionals by institute faculty members, in contrast to the way that many said they are treated normally by principals and others.

The one incentive that drew uniform praise from teachers was the credit toward certification and recertification, and in some cases toward a further degree, that was offered without cost to them. To most teachers, this compensated for whatever displeasure they may have felt at the size of the stipend. It should be noted, however, that, whereas the decision to credit participation in the institute toward the units or hours of courses needed for recertification or reassignment was left to the school districts, the decision to grant credit toward an M.A. rested entirely with the universities involved. In most cases, institute courses were pitched at the introductory or undergraduate level, so that only with extra work could graduate credit be earned for them. In those instances, individual teachers who wanted to earn graduate credit found it necessary to make special arrangements with university faculty members to undertake additional and more advanced work on their own.

Faculty instructors of the institutes were also sensitive to the conditions and surrounding of instruction and programs, and considered them to be among incentives to participation. More than one faculty member insisted that, while stipends were important, amenities were equally so. One, to engender *esprit*, provided each participant with a tee-shirt and hat emblazoned with "Honors Workshop 1984." Many provided in their funding for such things as refreshments during breaks. Occasionally, institute participants shared the preparation of food and drink. A few instructors attempted to take teachers to lunch or at least to join them at meals—"treating them," said one university professor, "as fellow professionals." In one institute, teachers were required by the district to sign in each day—"very bad and very unprofessional," remarked the faculty instructor. As a result of similar requirements, one faculty member believes, "very little dent" was made in the professional self-image of the teacher. One found it impossible to convince teachers to call him by his first name rather than "Professor."

Yet one or two faculty instructors believed that the teachers could not, and therefore should not, be treated as full professionals. One director argued that attendance at his institute was so good "because the teachers were *not* treated like fellow professionals. That is, they were made to know that their pay depended on their attendance. Otherwise, we could not have counted on them."

Faculty compensation was handled in a number of ways. In some cases, faculty members taught in the institutes in addition to their normal teaching loads and were compensated either from grant funds or from a university's budget as part of its contribution to the institute. The time spent by one institute director in teaching in the institute was considered as part of her regular teaching responsibilities; as a result, her academic-year teaching schedule was reduced and she received no additional compensation for the institute. In another instance, the institute director received released time from his normal teaching assignment during the spring of 1984 as compensation for his work in the institute.

## CHAPTER 5

# *Evaluation and Follow-Up*

The evaluation of any program is the most vexing aspect of its history—the intent, necessity, focus, and utilization of an evaluation usually falling to dispute.*

It cannot be reported that the evaluations of the 1984 summer mathematics and sciences institutes escaped challenge, nor that they were uniform, formal, or always carefully executed or well utilized. The need for evaluation was recognized by all. The strength of evaluation efforts is far less certain.

From the outset, the Council for Basic Education, as well as local institute leaders, saw the need for assessments during and after each institute. Local funding sources would insist on a report about the program. Local communities, whose taxes in most cases helped support the institutes, were entitled to know how the money was spent. The participating school districts and colleges certainly needed some measure, formal or informal, of the effects of the institutes on teachers' knowledge and effectiveness. The Council itself needed to know whether the efforts made by so many people were constructive and worth repeating.

As was discovered, however, views differed about what was to be evaluated. The division of opinion became apparent in a conference of representatives of the summer institutes convened by the Council in October 1984. At that meeting, some insisted that the stewardship of public funds necessitated not only detailed evaluations based upon scientific and statistical principles, but also a clear demonstration that the institutes had resulted in a measurable rise in middle and high school students' abilities as measured by standardized test scores.

That is to say, some argued that the acid test of the success of the institutes was a direct change in students' skills.

Others took a different position—that whereas the purpose of any teacher training was to enhance the teaching and learning of young people, the causal chain was indirect; positive results would be diffuse, difficult to measure, and delayed in appearing. They also believed that heightened teacher morale and improved instructional skills and subject knowledge were sufficient justification for repeating the summer's institutes.

This debate is certainly not resolved, but the differences of view highlight the need both to determine early what kind of evaluation is to be undertaken and to remain appropriately agnostic about its utility.

With one or two exceptions, assessments carried out during the summer of 1984 were afterthoughts to the hurried and complex planning process, a situation that suggests planning for assessments as an integral part of an institute will enhance its strength and utility. Despite the modest attention given to evaluation in the early stages of the 1984 institutes, however, each did in fact end up being subjected to five kinds of assessments.

The first was the continuing review by instructors and school district officials of the content and progress of an institute.

**By "evaluation," this report does not mean assessment of changes in the professional behavior of teachers participating in the institutes or in the test scores of their students,—although such evaluations would be possible and appropriate were funds and other resources available and budgeted.*

*Instead, by evaluation is meant an assessment, by the many parties to the institutes, of their many phases and components; of the perceived or reported effects of the institutes on the abilities, attitudes, and knowledge of teachers; and of the problems encountered and changes that should be made in the conduct of institutes.*

No institute avoided adjustment along the way, as instructors became aware of teachers' difficulties, as teachers' special interests emerged, and as the teachers' varying abilities sometimes required separating them for instructional purposes into more than one section. Instructors who made such mid-institute corrections are convinced that without them, teachers' increased frustration would have limited the effectiveness of instruction.

The second sort of evaluation was that undertaken by individual members of the Council's advisory committee. The committee had been formed in the spring of 1984, when the need for a group that would coordinate all the institutes and assess their effectiveness in general became apparent. Each member of the committee agreed to visit at least one institute, and to provide a written report of the visit and an appraisal of the institute's quality. With two exceptions, every institute was visited by a committee member.

The reports are not wholly consistent, since the committee—whose members were all experienced in various aspects of mathematics and science education—did not intend and were not expected to ask the same questions of every institute.

Nevertheless, their visits and the reports that resulted from them provided the Council with an independent and informed review of each program. In some cases, the committee members made recommendations on the spot, and their visits and reports formed one basis of an early fall advisory committee meeting and of early planning for 1985 summer institutes. Finally, the visits and resulting reports provided to community funding sources and school districts independent assurances about the strengths and weaknesses of local institutes.

The institutes were also examined and questioned in the preparation of this document, which is designed primarily to record the composite history of the institutes, to capture their common features and their differences, and thus to allow others to assess independently the shape and substance of these endeavors.

Perhaps the most important were the fourth kind of evaluations, those that the institutes conducted at their sites. These differed widely; some have not been completed, and it is not yet clear how the sponsoring universities, school districts, or funders will use them.

In this group, the most elaborate is that planned by the district that undertook to retrain some of its teachers in mathematics and science. This evaluation is distinctive in at least four respects. It is longitudinal, attempting to measure changes in teachers' skills and sentiments over an entire school year as they attend intensive follow-up sessions. It involves a minimum of two interviews with each institute participant, instructor, and administrator, as well as with school district officials. These interviews are continuing during the 1984-85 school year. The assessment is being carried out by an academic social scientist, under the supervision of the university's dean of graduate studies and research, and is employing standard social scientific principles. And, at $10,000, it is costly; funds are being contributed 50/50 by the local university and a private source.

The assessment aims to determine whether the objectives of the program were achieved; to identify the factors and individuals that contributed to or impeded accomplishment of the objectives; and to compare the performance of the teachers with that of other, regular district mathematics and science instructors. To assist in this evaluation, an eight-person review panel has been established to review all data and reports and to recommend improvements in possible future institutes.

No other evaluations were so extensive. In most instances, local school districts, colleges, and universities were more concerned to evaluate the institutes than were those corporations and foundations which helped to provide funding. Interest in evaluations differed widely, as did their extent and form. Some institute sponsors and leaders were content with the mid-course assessments of members of the Council's advisory committee. Others relied on informal, though frequent and continuing, reviews of the progress of instruction and the nature of the institute curriculum.

One handed out a questionnaire to participating teachers and a request for anonymous evaluations at the conclusion of the institute and will solicit a second anonymous written evaluation at the end of the follow-up program in the spring. Some left the responsibility of assessment to the school system, believing that the success of an institute can best be measured by subsequent changes in teachers' effectiveness as assessed by standard school means. Others are relying for evidence of institute results upon the success of the various kinds of follow-up activities planned in conjunction with most of the institutes.

The fifth and final element of evaluation for the 1984 summer institutes was a conference in October 1984 of representatives of each institute (including school officials and university faculty), foundation officers, and members of the staff and advisory committee of the Council for Basic Education. The conference met to review the entire enterprise, to propose alterations in future institutes, and to assess appropriate additional steps.

Although much of the discussion at the conference was aimed at advising the Council on its future role and at providing institute funders and leaders with information about the other institutes, some of it highlighted the differences of view recorded in this report. In particular, participants differed about the best methods and aims of evaluations.

They also expressed diverse views about the role that practice in the application of new knowledge and skills should play in the summer workshops. Some argued in favor of a concentration of effort upon new knowledge and problemsolving, leaving classroom methods to the follow-up sessions. Others made a case for scheduling methods practice in the institute proper.

All agreed that the experiences of these initial institutes should be recorded and made widely known, and that those responsible for past and future institutes should have the opportunity to exchange information and views.

Probably the best assessments of the institutes are the collective, though informal, observations of the teachers who participated in them. Not surprisingly, their views ranged widely, from praise to criticism. It is difficult to characterize all of them, but the following is a composite of the views and judgments expressed most often.

Most were "thrilled" by the emphasis upon subject content and the problemsolving approach. Although they almost uniformly found the early institute sessions "traumatic," they concluded in the end that the institutes were too short (one said that her math institute "should have gone on for another two or three weeks").

Many teachers said they were "appalled at how little they knew." They also learned "how poorly prepared elementary students are." They were unanimous in feeling that their confidence as teachers had greatly increased. Why was this so? Because "the text was put aside"; because they learned "to approach not just the problem at hand but all problems"; because the institute was "a lot more demanding" than any previous courses in the subject; and because the institute was not required but instead "required a deep personal commitment from me." A number of teachers, by their own reports and those of the faculty, became so excited by the experience that they have enrolled in M.A. programs at the colleges or universities where the institutes were held.

Teachers also had recommendations of their own. Some, critical of the subject-matter weaknesses of their colleagues, urged that institutes be made even more rigorous. Others believed that the instructors "didn't present the material in a way appropriate to a normal teacher."

Some urged that institutes be restricted to the most accomplished teachers, as a way of providing models and incentives for those less motivated or able. Such participants often welcomed inclusion of history or theory of the subject in the institute curriculum. One commented that it would be "short-sighted" to abandon theory in the interest of "mere problemsolving." In this vein, another suggested that institutes be offered for credit toward an M.A. degree, saying this would attract more people, "especially younger teachers."

As to the long-range effects of the institutes, most teachers were sanguine. They often cited "increase in self-confidence" and "increased mastery of the subject" as benefits. (In this, most institute directors concurred; one reported that 10 of the teachers in his institute began with "deep" mathematics anxiety, but that all conquered it and three finally admitted to really liking mathematics.)

One teacher expressed reservations about the effects of the institutes, saying he doubted that many of his colleagues, despite the institute experience, would be willing to spring free of old lesson plans and the textbook. He would be surprised, he said, "if more than 20 percent will do experiments other than those carried out in the institute."

## Follow-Up

With one exception, the nine 1984 summer institutes made provision for some kind of follow-up sessions. Most planned for monthly Saturday meetings, as few as five or as many as nine, some for the entire day, others for the mornings only. One anticipated only two meetings, *in toto*; another scheduled meetings two nights a week for the academic year.

Other variations included a one-day meeting during the summer of 1985, Wednesday afternoon meetings to avoid breaking into the teachers' weekends, a return for two weeks of work in the summer of 1985, and two visits during the year to other classrooms.

Generally, the follow-up workshops were planned to be led by the faculty instructors from the summer institutes, with the aid of the original teaching assistants. All of the follow-up sessions were designed to allow teachers to reflect on their progress and address together the difficulties they might have encountered, to take up the solution of mathematics and science problems not covered during the summer, to explore methods of instruction with their new knowledge and materials, and generally to sustain or regain their *esprit* and interest.

Most were planned in acknowledgement that the institute sessions did not allow sufficient exploration of teaching methods and classroom applications.

In a few cases, it was simply assumed that teachers would attend the follow-up sessions; in others, a portion of the stipend and full certification credit was withheld pending attendance at the follow-up meetings. Compensation for participation in at least two programs was governed by contractual union pay scales. The university that cosponsored one program planned to grant three hours of graduate credit upon completion of seven of nine monthly meetings between September and May.

The use of teachers who had participated in an institute as inservice instructors or in some element of inservice planning can be considered part of the follow-up activities of the institutes. However, very few concrete plans to utilize teachers from the institutes had been made by the end of the 1984 summer. This does not mean none will be asked to contribute to the education of their colleagues, but it does imply that the potential for extending the benefits of the summer institutes is problematic and may be lost.

There was among supervisors and teachers no consistent view about the likely effect of the institutes on inservice training. Many teachers expressed a desire, as one put it, to "spread the word" to fellow teachers. By that, most meant simply broadcasting word of an institute and its benefits to colleagues, in the hope that they would apply to a future program. Others had in mind trying to teach their colleagues, in informal inservice settings especially, about the problemsolving approach to mathematics and science that they had learned during the summer. Some had an almost evangelistic desire to offer assistance; some had not been asked by summer's end to do so; some anticipated never being asked.

Most school system officials had not yet made formal plans to utilize the new skills of participating teachers, or even of the teaching assistants. They expected teachers to return to their classrooms and individually to use their new-found knowledge. A few administrators said they planned to make formal arrangements for institute teachers to be used as inservice presenters or to write curriculum, or at least said they would urge principals to do so; some expressed the view that many of the teachers who had attended institutes would not, despite their enrichment, make good inservice instructors.

A curriculum supervisor from a system that chose its teachers in teams of two or three from each school had planned from the outset to use these teams for inservice education. Failure to make use as inservice instructors of teachers whose "knowledge and confidence had increased so much" would be "a waste of opportunity and resources," she said. Another curriculum supervisor anticipated that institute participants would be strong candidates to become department chairmen.

# *Conclusion*

This report has attempted to relate, in compressed form, the sequence of events and the challenges that made up the 11 mathematics and science institutes that the Council for Basic Education assisted in arranging during the summer of 1984. It has sought to do so by setting down the views, often mixed and sometimes at odds, of the many participants themselves, often allowing them to speak in their own voices.

There seem to be some lessons—both positive and cautionary—to be drawn from the summer's experiences. This concluding note seeks to set these forth.

- *Early clarification of the aims and emphases of an institute is all-important.*
- *Senior school officials, especially principals, should be responsible for distributing information about the institutes directly to the teachers whose applications are sought.*
- *Application packages are crucial to the assessment of applicants' strengths and weaknesses and should be carefully designed.*
- *The selection process should be shielded from partiality and should involve a combination of people from the schools and the participating college or university faculty.*

*Once the selection has been made—indeed, probably at the time the institute is first announced—one person should be made responsible for answering all inquiries, ironing out all problems, following up to ensure that all those selected for the institute respond, and notifying those on a list of alternates that a place for them has been found.*

- *Careful thought should be given to requiring an orientation session at which all aspects of the institute are canvassed.*
- *Evaluations of an institute should be planned early and undertaken formally.*

The 1984 summer institutes revealed, as one faculty member put it, "a real hunger" by teachers for new knowledge and advanced skills.

But another cautioned, "You cannot make more than a small dent with a single summer's program, whether it runs for two weeks or eight weeks." One school official said he would be dismayed to see "Sputnik revisited," with much initial excitement and then dashed hopes.

Bearing in mind both of these points, the Council for Basic Education concludes that attempts such as the 1984 summer institutes to enrich the experiences of American teachers in their subject areas are justified. We hope that this report contributes to the ultimate goal of better schooling for our children.

# *Appendix*

The following are the school districts, universities, and funders who participated in the 1984 summer mathematics and science institutes described in this report.

## Chicago/Mathematics

**School District**
Chicago Public Schools
1819 W. Pershing Road
Chicago IL 60609

**School District Contact Person**
Dr. Dorothy Strong
Director of Mathematics
Chicago Public Schools
1819 W. Pershing Road
Chicago IL 60609
Telephone: (312)890-7945

**University**
University of Illinois at Chicago
P.O. Box 4348
Chicago IL 60680

**University Contact Person**
Dr. A.I. Weinzweig
College of Liberal Arts and Sciences
Department of Mathematics, Statistics, and Computer Science
University of Illinois at Chicago
P.O. Box 4348
Chicago IL 60680
Telephone: (312)996-8612

**Funding Sources:** The Carnegie Corporation and the Joyce Foundation.

**Description:** Algebra for elementary and secondary school mathematics teachers.

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## Cleveland/Mathematics

**School District**
Cleveland Public Schools
1380 East Sixth Street
Cleveland OH 44114

**School District Contact Person**
Dr. Reginald Green
Assistant Superintendent
Cleveland Public Schools
1380 East Sixth Street
Cleveland OH 44114
Telephone: (216)574-8666

**University**
John Carroll University
University Heights OH 44118

**University Contact Person**
Dr. Leo J. Schneider
Department of Mathematics
John Carroll University
University Heights OH 44118
Telephone: (216)491-4351

**Funding Sources:** The Carnegie Corporation, the TRW Foundation, the Standard Oil Company of Ohio and the Cleveland Public Schools.

**Description:** Problemsolving for middle and high school mathematics teachers.

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## Dallas/Mathematics

**School District**
Dallas Independent School District
Lincoln Instructional Center
5000 S. Oakland
Dallas TX 75215

**School District Contact Person**
Dr. Winston Hoskins
Director
Science and Health
Dallas Independent School District
Lincoln Instructional Center
5000 S. Oakland
Dallas TX 75215
Telephone: (214)426-3234

**University**
University of Texas at Dallas
P.O. Box 688
Richardson TX 75080

**University Contact Person**
Dr. Fred Fifer
Director, Science Education
University of Texas at Dallas
P.O. Box 688
Richardson TX 75080
Telephone: (214)690-2497

**Funding Sources:** The Atlantic Richfield Foundation, the Dallas Independent School District, and the University of Texas at Dallas.

**Description:** Training for certification in secondary school mathematics for teachers of other subjects.

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## Hartford/Mathematics

**School District**
Hartford Public Schools
249 High Street
Hartford CT 06103

**School District Contact Person**
Dr. Dino A. Galiano
Assistant Superintendent for Instructional Support Services
Hartford Public Schools
249 High Street
Hartford CT 06103
Telephone: (203)722-8646

**University**
University of Hartford
West Hartford CT 06117

**University Contact Person**
Dr. Raymond McGarney, Jr., Chairman
Mathematics/Physics/Computer Science Department,
University of Hartford
West Hartford CT 06117
Telephone: (203)243-4203

**Funding Sources:** The Carnegie Corporation, the George I. Alden Trust, and the Hartford Public Schools.

**Description:** Algebra for 7th and 8th grade mathematics teachers.

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## Los Angeles/Mathematics

**School District**
Los Angeles Unified School District
450 N. Grand Avenue
Los Angeles CA 90012

**School District Contact Person**
Dr. J. Philip Linscomb
Associate Superintendent for Instruction
450 N. Grand Avenue
Los Angeles CA 90012
Telephone: (213)625-6040

**University**
Harvey Mudd College
Claremont CA 91711

**University Contact Person**
Dr. John B. Rae
Program Director
Harvey Mudd College
Claremont CA 91711
Telephone: (714)621-8000, ext. 3845

**Funding Sources:** The Atlantic Richfield Foundation, the National Science Foundation, the TRW Foundation, the W.M. Keck Foundation, and the Northrop Corporation.

**Description:** Algebra for high school mathematics teachers.

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## San Francisco/Mathematics

**School District**
San Francisco Public Schools
135 Van Ness
San Francisco CA 94102

**School District Contact Person**
Dr. Carol Choye
Associate Superintendent for Instruction
San Francisco Public Schools
135 Van Ness, #212
San Francisco CA 94102
Telephone: (415)565-9701

**University**
University of San Francisco
Ignatian Heights
San Francisco CA 94117

**University Contact Person**
Dr. Carl J. Naegele
Associate Dean
College of Arts and Sciences
University of San Francisco
243 Harney Science Center
San Francisco CA 94117
Telephone: (415)666-6433

**Funding Sources:** The BankAmerica Foundation.

**Description:** Problemsolving for high school mathematics teachers.

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## Spartanburg/Mathematics

**School District**
Cherokee County Public Schools
Greenville County Public Schools
Spartanburg County Public Schools

**School District Contact Person**
Patricia Borenstein
Principal
Stone Elementary School
412 Wilton Street
Greenville, SC 29609
Telephone: (803)232-4231

**University**
Wofford College
Spartanburg SC 29301

**University Contact Person**
Dr. Lee O. Hagglund
Director
Problem-Solving Institute for Mathematics Teachers
Wofford College
Spartanburg SC 29301
Telephone: (803)585-4821

**Funding Sources:** The Romill Foundation.

**Description:** Problemsolving for secondary school mathematics teachers.

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## Dallas/Science

**School District**
Dallas Independent School District
Lincoln Instructional Center
5000 S. Oakland
Dallas TX 75215

**School District Contact Person**
Dr. Winston Hoskins
Director
Science and Health
Dallas Independent School District
Lincoln Instructional Center
5000 S. Oakland
Dallas TX 75215
Telephone: (214)426-3234

**University**
University of Texas at Dallas
P.O. Box 688
Richardson TX 75080

**University Contact Person**
Dr. Fred Fifer
Director, Science Education
University of Texas at Dallas
P.O. Box 688
Richardson TX 75080
Telephone: (214) 690-2497

**Funding Sources:** The Atlantic Richfield Foundation, with additional funding from the Dallas Independent School District and the University of Texas at Dallas.

**Description:** Training for certification in earth science and physical science for teachers of other subjects.

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## Los Angeles/Science

**School District**
Los Angeles Unified School District
450 N. Grand Avenue
Los Angeles CA 90012

**School District Contact Person**
Dr. J. Philip Linscomb
Associate Superintendent for Instruction
450 N. Grand Avenue
Los Angeles CA 90012
Telephone: (213)625-6040

**University**
Harvey Mudd College
Claremont CA 91711

**University Contact Person**
Dr. John B. Rae
Program Director
Harvey Mudd College
Claremont CA 91711
Telephone: (714)621-8000, ext. 3485

**Funding Sources:** The Atlantic Richfield Foundation, the National Science Foundation, the TRW Foundation, the W.M. Keck Foundation, and the Northrop Corporation.

**Description:** Basic science for high school science teachers.

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## Pittsburgh/Science

**School District**
Pittsburgh Public Schools
Administration Building
341 S. Bellefield
Pittsburgh PA 15213

**School District Contact Person**
Dr. Stanley J. Herman
Assistant Superintendent for
Instructional Development
Pittsburgh Public Schools
Administration Building
341 S. Bellefield
Pittsburgh PA 15213
Telephone: (412)622-3950

**University**
University of Pittsburgh
3939 O'Hara Street
Pittsburgh PA 15260

**University Contact Person**
Dr. Audrey Champagne
Senior Scientist
Learning, Research and Development Center
University of Pittsburgh
Pittsburgh PA 15260
Telephone: (412)624-4821

**Funding Sources:** The Westinghouse Educational Foundation, the H.J. Heinz Company Foundation, and the Pittsburgh Public Schools.

**Description:** Middle school science teachers.

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## San Diego/Science

**School District**
San Diego Public Schools
4100 Normal Street
San Diego CA 92103

**School District Contact Person**
Dr. Thomas Payzant
Superintendent of Schools
San Diego Public Schools
4100 Normal Street
San Diego CA 92103
Telephone: (619)293-8418

**University**
University of California San Diego Extension
La Jolla CA 92093

**University Contact Person**
Dr. Mary L. Walshok
Dean
University of California San Diego Extension
La Jolla CA 92093
Telephone: (619)452-3411

**Funding Sources:** The TRW Foundation, the Parker Foundation, and anonymous donors.

**Description:** Biology for high school science teachers.

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